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**WOODS HOLE OCEANOGRAPHIC INSTITUTION**

**Woods Hole, Massachusetts**

**14** WHOI-REF-50-22

Reference No. 50-22

**6** OCEANOGRAPHIC RESEARCH •

conducted during the period

January 1, 1950 - March 31, 1950

**12** **15**

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

**9** Periodic Status Report, No. 15, 1 Jan - 31 Mar 50.  
Submitted to the Oceanographic Division  
Hydrographic Office  
Under Contract **15** N6onr-277  
Task Order No. 1, NR-083-004  
with Office of Naval Research

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**11** June 1950

APPROVED FOR DISTRIBUTION

C. O. D. Graham  
Director

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According to the terms of Contract N6onr-277, Task Order No. I, NR-083-004, the work to be performed by the Contract shall consist of the following:

1. The Contractor shall furnish the necessary personnel and facilities for, and, in accordance with any instructions issued by the Scientific Officer or his authorized representative shall

(a) conduct surveys and research, and analyze and compile data and technical information, prepare material for charts, manuals and reports, and foster the training of military and civilian personnel in the following fields of oceanography;

- (i) permanent currents;
- (ii) interaction of the sea and atmosphere, including wind waves, swell and surf;
- (iii) distribution of organisms;
- (iv) characteristics of the sea bottom and beaches;
- (v) tides, tidal currents and destructive sea waves; and
- (vi) physics and distribution of sea and terrigenous ice\*;

and perform the following work in particular;

- (1) (Confidential)
- (2) collection of analyses of bathythermograph observations\*\*; and
- (3) conduct of a wave measurement program in the Atlantic.

\* Research in connection with relations between North Atlantic sea ice and Arctic weather was transferred to Task Order V of Contract N6onr-277 on May 15, 1949 and will be reported in a separate Periodic Status Report.

\*\* The tabulation and filing of bathythermograph observations was transferred to Task Order VI of Contract N6onr-277 on May 15, 1949.

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This report contains a summary of work carried out under Contract N6onr-277, Task Order No. I by the Woods Hole Oceanographic Institution under the following headings:

*Partial contents*

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Papers Published

"Horizontal Diffusion Due to Oceanic Turbulence", Jour. Mar. Res., Vol. VIII, No. 3, pp. 199-225, December 1949, by Henry Stommel.

"The Gulf Stream, a brief history of the ideas concerning its cause", Sci. Monthly, Vol. LXX, No. 4, pp. 242-253, 1950, by Henry Stommel.

Papers Submitted for Publication

"A Study of Mixing Processes over the Edge of the Continental Shelf" by A. R. Miller has been accepted by the Journal of Marine Research for publication.



### Introduction

Completion of this progress report was seriously delayed by the Director's unexpected visit to England during April and May and by the absence of many members of the staff during June because of Operation CABOT.

It may be of interest to report here very briefly on the status of physical oceanography in England. The new National Oceanographic Institute has been activated to the point where field work is now in progress, but as yet (May) a site for the laboratory has to be selected. During the spring both the WILLIAM SCORSEBY and the DISCOVERY II departed for Antarctic waters. These vessels have been thoroughly refitted and are manned by civilian crews. They will be away from England for about two years.

DISCOVERY II was visited two days before she left London by Dr. G. E. R. Deacon, Dr. E. C. Bullard and the writer. By modern standards, instrumentation remains primitive and the program for the cruise seemed rather leisurely. In general, only one deep station a day will be occupied. The objective is to fill in gaps in the existing data of the DISCOVERY Committee.

It is expected that by the time the field parties return a headquarters laboratory will be in operation and new instrumentation will have been constructed. For example, Dr. Bullard is designing equipment for measuring the heat flow through the bottom sediments, based on his experience off California last year. In all probability, the laboratory will be in the neighborhood of London so as to be near the major universities.

It is evident that the main interest in oceanography among university scientists in England is in the field of geophysics. It can be expected that the program of the new National Oceanographic Institute, once the ships return, will for a while be mainly centered around geophysical exploration of the waters off the European coast. There seems to be a lack of people interested in the more classical aspects of oceanography and it is partly for this reason that the new laboratory has been organized.

### Operation CABOT

During the period of this report, plans for a multi-ship survey of the Gulf Stream were under discussion. In a letter to the Hydrographer dated 13 January 1950, the

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needs for such a survey were outlined. Since it is expected that a good fraction of the work under this contract during the next year or so will center around the results achieved on Operation CABOT, as the survey came to be called, it may be pertinent to summarize here the pre-CABOT situation.

Under this contract during the past several years, we have been trying to develop a better picture of the current pattern existing at any given time in a considerable area of the ocean. Attempts to use the conventional techniques of oceanography immediately after the war produced very indifferent results. For example, during 1946-1947 the ATLANTIS systematically occupied about 180 deep, water bottle stations in the triangle between Cape Hatteras, Bermuda and Puerto Rico. It is hardly an exaggeration to state that no new understanding of the circulation in this area resulted from this very considerable operation. About eight months of ship's time was involved. We achieved an orderly grid of deep observations covering the whole area, yet neither the T-S correlation technique nor the calculation of dynamic heights has disclosed anything of particular interest. We cannot even describe the distribution of temperature and salinity in the area significantly better than was possible from the previous scattered observations.

While over a period of many years the systematic covering of the ocean with deep temperature and salinity observations may lead to some further advances, the Law of Diminishing Returns has evidently begun to operate. Two new approaches to the circulation problem were therefore evolved and have been under development of recent years. The first depends on improved navigation and the second on securing long series of continuous data at fixed points within a given area. Since with Loran we could obtain fairly good navigational control along the Gulf Stream between Cape Hatteras and the Grand Banks, we turned our attention to this area. Nevertheless, the search for more accurate and more widely applicable navigational techniques continues to be a pressing need in oceanography. Nothing but the best possible navigation gives promise of leading to the solution of a number of problems in physical oceanography. While we are still extremely hopeful of the usefulness of unattended instruments, this part of our program cannot begin to bear fruit until after several years have elapsed.

The preliminary work along the edge of the Gulf Stream emphasized the streaky nature of ocean currents, their variability in speed and position, and the formation of large eddies on either side of the mean track. Such conditions are probably extreme in the western part of each ocean, but the possibility that they are rather general phenomena should



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not be overlooked. For example, during the summer of 1949 the ATLANTIS followed the Gulf Stream System northeastward to about mid-ocean, and as far as can be judged through celestial navigation and the bathythermograph the character of the current remained unchanged.

As the new techniques of studying currents developed, doubts frequently arose as to the proper interpretation of the sorts of data that could be secured by a single ship, no matter how skillfully she might be used. It is a great satisfaction that the preliminary results from CABOT indicate that our previous interpretations have been essentially correct. Now that we can describe with some assurance the sort of circulation system that we have to deal with near the surface of the ocean, there is good hope that our understanding of it will advance more rapidly. Especially it is hoped that theoretical studies can be guided into fruitful channels.

The modern Gulf Stream surveys have all been undertaken during the spring and early summer months, during the period just before the pronounced summer decline in transport occurs. It is furthermore the season of southwesterly and southerly winds so that air temperatures are seldom more than a few degrees lower than water temperatures. In November, with rapidly increasing transport and pronounced convection in both mediums, quite a different situation might prevail. However, we are now in a much better position to proceed with the study of contrasting conditions using a single ship, for we are fairly certain that our picture of the typical spring situation is reliable.

A remaining major problem is the study of the velocity change with depth. The technique used by Dr. Edmond Watson last summer appears to give reliable results and he is returning to Woods Hole this summer to undertake a more extensive series of measurements.

The pressing need now is for surface current surveys in other parts of the ocean. For example, is the current also streaky in the trade wind region? No marked improvement in Sonar Charts or Submarine Supplements can be made until such a basic question is answered.

#### Oceanographic Surveys off East Coast of United States

Two cruises have been made during the quarter in ALBATROSS III, the U. S. Fish and Wildlife Service vessel, in which data have been gathered in the New York Bight and off the coast of North Carolina.

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During Cruise 30, 4-13 January, acidity and iron determinations were made in the wake of the acid disposal barge "Sayreville" during an entire dumping period to determine the rate of diffusion of the effluent during winter conditions. The thirty-seven oceanographic stations were reoccupied over a grid in the New York Bight area in which analyses of iron and oxygen content were made immediately and salinity samples for later analysis were collected. Sixteen drift bottles and ten drift cards were released at each of the thirty-seven stations. In addition, a detailed oceanographic survey of the waters over the continental shelf off North Carolina was made with sea samplers and auxiliary sea samplers used alternately. Analyses of oxygen and phosphorous content were made immediately on alternate legs across the shelf. Salinity samples were collected for later analysis. Sixteen drift bottles and ten drift cards were released at each of fifty-one positions in Carolina waters. Bathythermograms were also made along the route between the New York area and northern North Carolina and eight drift bottles and five drift cards were released at five positions. The STD and Fathometers were operated continuously throughout the cruise. Accurate positioning was determined through frequent use of Loran.

#### Summary of Cruise 30

1608 salinity samples were collected

655 oxygen determinations were made on board

463 phosphate " " " " "

277 iron " " " " "

402 bathythermograph lowerings of which 161 were with the multiple sea sampler, and the remainder with auxiliary sea samplers

1450 drift bottles and 900 drift cards were released at 93 positions. Of these there have been to date (30 June):

25 bottle returns from 5 stations in the N. Y. area

10 card " " 3 " " " " "

26 bottle " " 6 " " " Carolina area

1 card " " 1 " " " "



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During Cruise 32, 25 February to 6 March, the temperature and salinity survey off North Carolina was repeated using multiple sea samplers and auxiliary sea samplers alternately and the STD. Bottom samples were also obtained by fixing the sediment trapping part of a "scoopfish" on the forward end of the auxiliary sea sampler in place of the nose piece (Figure 1). Drift bottles were released at forty-nine positions.

#### Summary of Cruise 32

1096 miles in sections were covered over North Carolina continental shelf

341 bathythermograms were made

164 with multiple sea samplers, the remainder with auxiliary sea samplers

1298 salinity samples were collected

111 bottom sediment samples were collected

550 drift bottles were released at forty-nine positions. Of these there have been 7 returns to date (30 June) from 3 positions.

The field work on Cruises 30 and 32 was supervised by Dr. Ketchum and Mr. Bumpus.

The material gathered from the seven cruises over the Carolina shelf is in the process of being studied for the preparation of a report on the oceanography of that region which will cover the January to June period.

#### Arctic Oceanography

On the winter cruise of the Navy icebreaker, U.S.S. EDISTO (AGB-2), Martin J. Pollak and William G. Metcalf made oceanographic observations at the request of the Hydrographic Office and the Office of Naval Research. The EDISTO left Boston on 18 January returning unexpectedly two weeks later. She left again on 8 March and returned on 5 May after a cruise extending into Baffin Bay. Due to poor weather, plus the fact that oceanography had a very low priority, only five hydrographic stations were occupied and about 50 bathythermograph lowerings were made. In addition, ice observations were made regularly whenever the ship was in the vicinity of ice.





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A hydrographic winch was put aboard the EDISTO by the Woods Hole Oceanographic Institution and proved to be satisfactory until the electric motor burned out. This motor was replaced by one loaned by the ship and the winch again was used satisfactorily. The winch was left on the ship for use during the coming summer operation in the arctic.

A confidential report of the program was submitted to the Hydrographic Office for approval early in June. A copy was also provided for the USS EDISTO.

Salinity Titrations and Calibrations of Thermometers

The following groups of salinity samples have been titrated:

USS EDISTO	17
BLUE DOLPHIN	60
ATLANTIS, Cruise #157	1,290
U.S. Public Health Service	25
Miscellaneous	25
	<u>1,417</u>

This work has been carried out by three full-time laboratory assistants under the supervision of Mr. Pollak.

During this period the salinity laboratory was moved into a constant temperature room and air conditioning was provided.

The following thermometers have been received for calibration:

Scripps Institution of Oceanography	1
U.S. Navy Hydrographic Office	20

Statements of examination have been issued for the following groups of thermometers:

	Ice Point only	Index Corr.	Thermometer Unsatisfactory
University of Miami		5	1
U. S. Coast Guard		9	
U. S. N. Hydrographic Office	10	2	2
WHOI		2	

This work has been carried out by Mr. Pingree under the supervision of Mr. Bumpus.

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Assistance to the Hydrographic Office

One group of three enlisted personnel has received one weeks' training in the laboratory on the operation of the bathythermograph, accurate presentation of the ships track and temperature profiles in connection with Project AMOS

Sea Surface Wave Studies

In cooperation with a radar group from the Naval Research Laboratory detailed wave pole observations were secured off Bermuda during a period of about six weeks. NRL furnished the vessel and is financing the analysis of these data from the standpoint of sea return. However, they will also be generally useful for wave research. The observations cover a wide range of sea conditions in a part of the open ocean for which the weather maps are particularly complete. Two wave poles were photographed, one graduated in 6-inch divisions and the other in 1-inch divisions. Thus, the data include the whole spectrum of surface wave phenomena. Since a powerful telephoto lense was used, the moving picture record can be read in most cases to a tenth of a division on the wave poles. The experience gained in securing these data is also of considerable importance to wave research.

Unattended Oceanographic Instruments

Little work has been done on the temperature recorder since the last report. It was hoped that comments from potential users of the instrument would indicate whether or not the present model should be altered. Difficulty has been found in the means of projecting the Lucite slide to obtain enlarged temperature records. We are taking steps to design or obtain the temperature elements at lower cost. The present element costs \$50.00 apiece and it should be possible to reduce this cost to about \$5.00. It has not been determined that the rectangular coordinates of the records are entirely necessary. A more inexpensive instrument could be built using a circular chart. In the meantime, one instrument is being tested underwater.

Internal parts of the first experimental current meter have been ninety per cent completed. The cast and allied equipment is about twenty per cent completed.



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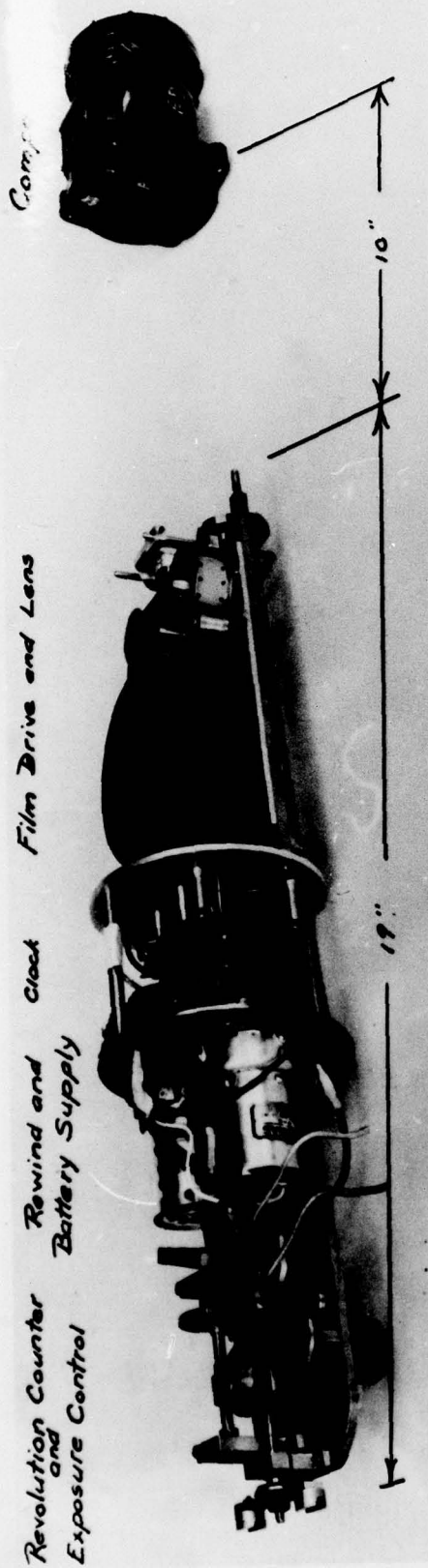
The case consists of "Everdur" castings for the ends and for the O-ring seal plates. These castings are joined by sections of brass tubing; however, it is contemplated that Everdur tubing will be used. The length of the assembled case is thirty-three inches and diameter five inches. This does not include the tail assembly.

The propeller, which is included in the tail assembly, is a five bladed Everdur propeller and is magnetically coupled to the revolution counter inside the case. The propeller utilizes sapphire ball bearings and preliminary experience indicates that it has a threshold current velocity of less than 1/20 knot. The calibration curve is a straight line from less than 1/20 knot to 1/2 knot.

Figure 2 illustrates the inner mechanism of the current meter. The revolution counter and exposure control has a shaft which is mounted on conventional ball bearings and receives its rotational motion by a simple magnetic coupling from the outside propeller. This portion of the mechanism is connected electrically to the compass in the nose piece of the instrument. The present arrangement allows the illumination of the compass face to be turned on for a period of approximately one-half second for every 500 revolutions of the propeller. The energy required to trip the switch is stored evenly over the 500 revolutions so that extremely small energy is required from the propeller.

The clock rewind, clock, film drive and lens are mounted as a unit and are encased in a light-tight housing which is not illustrated. Sixteen millimeter film is driven at the rate of 1/8 inch per hour. The lens is made to traverse laterally on the film at a linear rate and to return quickly, resulting in a sawtooth pattern on the film. It requires one hour to make the slow traverse and about 1/2 second for the return.

One hundred feet of film is stored in the upper magazine; and at the film travel rate of three inches per day, the film will last 400 days. The film record and enlarged print illustrates an example of the propeller being driven at a constant speed while the compass is slowly rotated by a magnetic field. It is expected that we can have the instrument ready for the towing trials near the first of June and will have the mooring equipment evaluated by the first of July.



Photographic Record and Enlargement  
of Synthesized Current Recording

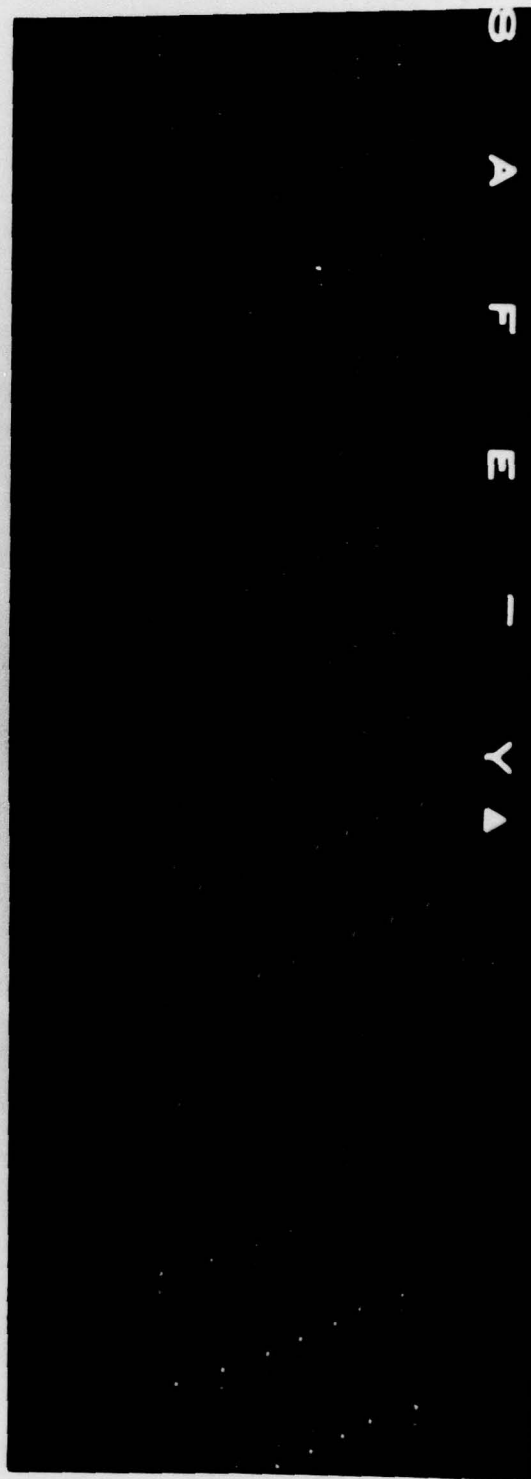


FIGURE 2

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PERSONNEL

<u>ASSIGNMENT</u>	<u>NAME</u>	<u>TITLE</u>	<u>TOTAL MAN DAYS*</u>
GENERAL TASK ASSIGNMENT	C. O'D. Iselin** A. C. Redfield F. C. Ryder Jeanne M. Backus	Director Associate Director Assistant to the Director Secretary	52
HYDROGRAPHIC OBSERVATIONS AND ANALYSES	Dean F. Bumpus N. T. Corwin Carlyle Hayes John Holmes, Jr.  W. G. Metcalf  A. R. Miller Martin J. Pollak L. V. Worthington	Oceanographer Hydrographic Technician Hydrographic Technician Research Associate in Physical Oceanography Research Associate in Arctic Oceanography Research Associate Physical Oceanographer Hydrographic Technician	463
CURRENTS AND WAVES	Louise Allen Ruth Barker Barbara Bunker Richard Dimmock Louise Dudley Thomas Duke H. B. S. Hall Mary Hunt John Hurley H. R. Seiwel Henry Stommel W. S. von Arx Dorothy Yarnold	Laboratory Helper Technician Technician Technician Secretary-Technician Research Assistant Technician Statistical Technician Hydrographic Technician Physical Oceanographer Physical Oceanographer Physical Oceanographer Laboratory Helper	856½
PHOTOGRAPHY AND DRAFTING	F. A. Bailey D. M. Owen G. G. Pasley Claude Ronne Eva Shelnut John Stimpson	Draughtsman Photographer Draughtsman Photographer Draughtsman Draughtsman	175
MISCELLANEOUS SHOPWORK AND LABORATORY ASSISTANCE			306½

\* Man Day consists of 8 working hours.

\*\* Time not included in figures for man days.

GRAND TOTAL 1,655

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